BILKENT UNIVERSITY
ENGINEERING FACULTY
DEPARTMENT OF COMPUTER ENGINEERING

CS 399

SUMMER TRAINING REPORT

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Performed at

Erik Games Software Technologies

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1 Introduction

I did my internship at Erik Games. The focus of the company is developing PlayStation games for different age groups. I've always wanted to be a game developer since I begin the computer science department at Bilkent University. Therefore, my main motivation was learning the game developing in that company.

During my internship, my supervisor was expecting me to start a new game project in which they've already had a subject, while they were working to finish their current game. He made a group of two people, that were me and another intern, and gave us the game subject. First of all, he wanted us to develop the subject and plan the game. Then expect from us to create the game's feature without a nice graphical user interface which they will use it while they were developing the whole game.

The project is aimed at a kind of story game. The whole game built as a third-person character game. Therefore, we (me and my groupmate) created different puzzles, trace mechanisms in the game to force the user to develop their critical thinking abilities and train the users' brains.

I involved all of the parts in the project which were planning the game such as deciding features for the main character, creating the environment of the game, creating the basic movements of the characters by using artificial intelligence for non-player characters and some visual effects like night mode, thermal mode, etc. Also, try to work with another person for all of these steps. Dividing the work, learning to use Github for Unreal Game Engine to work together.

2 Company Information

2.1 About the company

Erik Games has been working since February 2019. They are quite a new company but they have already two games and some other packets for PlayStation's view in the market. They're also a small company that works inside Atom Game Center in ODTU Teknokent with only two people. These two people who set up the Erik Games, both worked on Kodobur Game which makes them experienced in the Game industry.

2.2 About your department

Because they are a small company, there exists only the game development department. The company owners and most of the interns worked on this game development part and one of the interns worked in the graphic design department for the games. I worked development part with another intern who is also a computer science student in Bilkent which we mostly worked with developing a first-person character game with Unreal Engine 4.

2.3 About the hardware and software systems

While I was working there, I worked on my computer. Also, other people worked there via using their computers to create the game. They also use specialized hardware to create video games which are called Game Development Kit (Dev-Kit). By using dev-kit, they decrease the disadvantages of creating the video game for PlayStation such as finding the bugs by playing them and running Unreal Engine 4 without any delay. [1] All of the people in the company were using the Windows 10, and Unreal Engine to create the games as software systems.

2.4 About your supervisor

Ömer Toker was my supervisor. He graduated in 2016 from the ODTU computer science department. He graduated from his master's degree in 2018 from ODTU with a Cyber Security title. He worked on Genkom Game, Kodobur Game as a game developer. Then, he is working in Erik Games Software Technologies as Co-Founder.

3 Work Done

3.1 Determine Requirements and Details of the Game and Designing the Game

On the first day of my internship, I met with the people in the company, and the Atom Game Center in the ODTU Teknokent was introduced. They showed us their current project that is about to publish. My team was formed by my supervisor. One of the other interns who began at the same time to the internship with me, and also studying computer science in Bilkent was my teammate.

Then, our supervisor talked about the game project idea that they want to develop for their company. They only had the idea that they wanted to make a game about the Alien who trapped in the 51st Area in Amerika. They said it will be a story game in which there will be no war or gun. The player character will try to escape from the area by using the hints and solving the problems and the alien's most important property was it can go inside of the other people for a while. He wanted that we needed to come up with ideas and scenarios for the game and make brainstorm with the other intern and tell our thoughts to him tomorrow.

I and my teammate made a brainstorm about the game features and came up with the ideas and concluded some of the game features as below:

- The alien will wake up in a room that he has no idea who is he or where is he. In the room, there is a doctor who is working with some calculations and not looking at the alien at that time
- Then unconsciously he gets in the doctor's body. Then he looks at the calculations and reports that the doctor was holding and he learns that he is the alien in this world and after his spaceship crashed in the world, he was brought to this place.
- Then by using the doctor's body, he goes out of the room. Then he goes to the computer room with some hints and using other bodies or itself. Also, he

has a time limit for being inside a body and this time decreases with every body he gets inside.

- In the computer room he will hack one of the computers based on the hints around to learn all the information about the crash, all the stuff he had like some kind of phone to reach other aliens that he had, and shut down the security cameras. By using the phone kind thing he will get in touch with his friends and refresh his memory as he came to the earth for saving his other alien friend. He wanted to find his friend.
- He will pass the corridor which is full of soldiers. Then he reaches the gun room and finds a bomb to disposal of the power room.
- After deactivating the power, the alien goes inside of a meeting in a high ranking person's body there.
- Then, by going to the crypto room, he hacks the computer again and finds out where is his spaceship and his friend.
- He goes and gets his friend and goes to the hangar to get the spaceship.

After our discussion for the game, we discussed these ideas with the supervisor and fixed every unclear point. Then, he told us to work on Unreal Engine 4 (UE4), and try to find out how to do this game.

3.2 Division of Work

After researching for a while, I and my teammate came up with two different ideas to implement the game. I found that the behavior tree is a suitable way to implement non-player characters with AI. Then my teammate found out that he can do the same property without a behavior tree. Then, we told this to our supervisor and he wanted to see the result of both ways. Then, for the first and half of the second week, we worked on this.

Because the example without a behavior tree is simpler than the behavior tree one, my teammate started to implement some of the features to the game that he started. Therefore, When I finished implementing the behavior tree for the game, my teammate finished non-player character's patrolling and switching the body. I will mention more about the behavior tree that I made in section 3.4.

Therefore, we showed our results to the supervisor and decided to go on without a behavior tree because we couldn't combine the behavior tree that I worked for with my team mate's project. After we decided to go on without a behavior tree, we needed to learn to work on the same project in UE4. Then we spent about three days to find out a way to work with the same project in UE4 together. I will mention this part in section 3.5.

After figuring out the Github, we divided the remaining features like he solved the bugs in the part he has already done. He worked on killing people after getting out of the body immediately, carrying the deaths bodies, patrolling of non-player character and seeing and hearing the player character by soldiers. I had worked on the behavior tree to implement patrolling seeing and hearing of the non-player characters. After that, I added thermal and the night vision to the game create some hints to open the doors, created the hacking system to the game, laser doors, opacity rules for some features, and made a research for hand tracking not to implement but to use in the game to explain the supervisor.

3.3 Research for Project and Learning the Necessary Tools

For the first week and half of the other week, we worked on learning the UE4 within the scope of game features. We worked on creating a third-person game and convert it to the first person game. I've worked on the non-player character which I have learned to create it with a behavior tree that I will explain in section 3.4. During the internship researching for the game did not end. I've always searched for how to implement the game's features.

3.4 Begin Creating the Game Features

As I mentioned above, I made a behavior tree for non-player characters. Behavior trees are UE4's asset that is used to create artificial intelligence (AI) for a non-player character (NPC) in the game [2]. To create the AI, the blackboard feature is needed. This blackboard feature keeps the so-called

variables that represent the states. For example, in our game I had some states for NPC like idle, patrolling, seeing the player and hearing the player, seeing the non-player character as in figure 1.

By this tree, the NPC can decide which state he needs to go and on that state what he has to do. For instance, in the state of FindNextPatrolPoint under the can't see the player and NPC not seen, there is a class named like this. This class setting the predefined patrol points, when the player goes to that patrol point it finds the next one then moves to that location if it gets to end of the patrolling points with a mode operation it turns back to the first point. In figure 2, an NPC is patrolling.

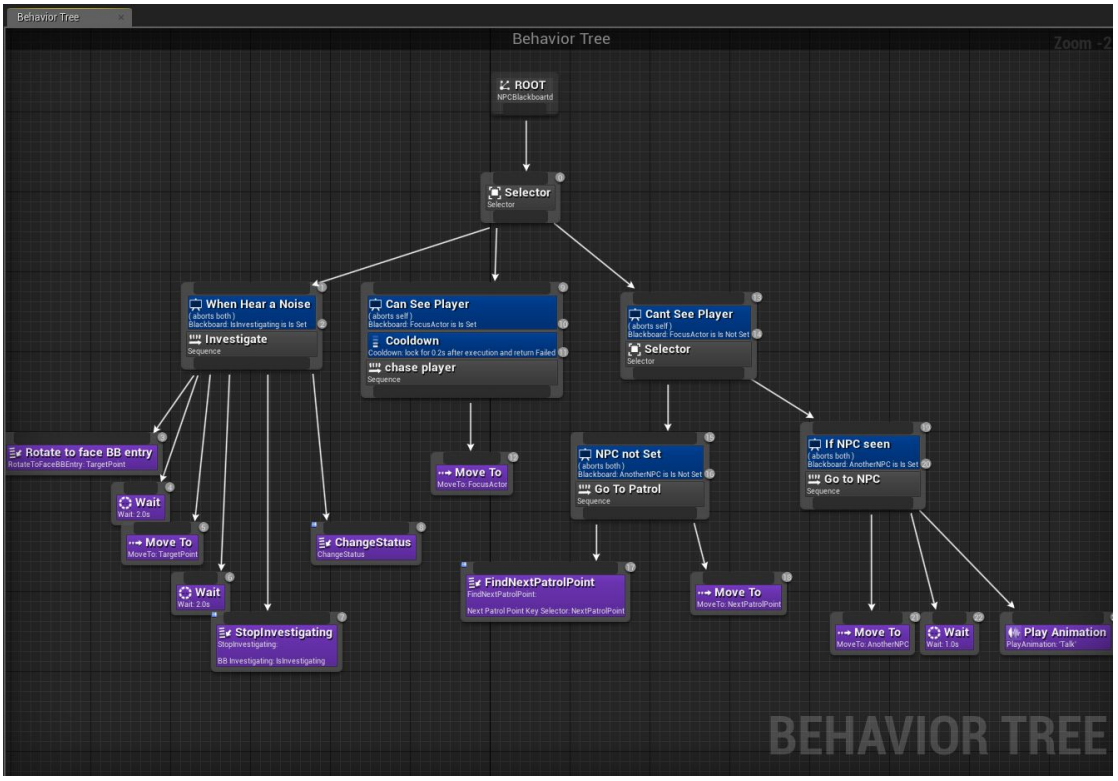

Figure 1 Behavior Tree

Figure 2 Patrolling NPC

I implemented an AI sight property to these NPC's. which help them to see the world around them. The NPC sees a determined circle with a certain radius and a certain angle for example, I gave them 600 pixels of radius and 90 degrees of angle to see them around. Whenever the player character enters their sight region, The behavior tree's state changing and chasing the player like in figure 3 and catching like in figure 4. Also, I implemented that whenever NPC hears a voice by adding the hearing property, he searches around and chasing the place where the noise came from.

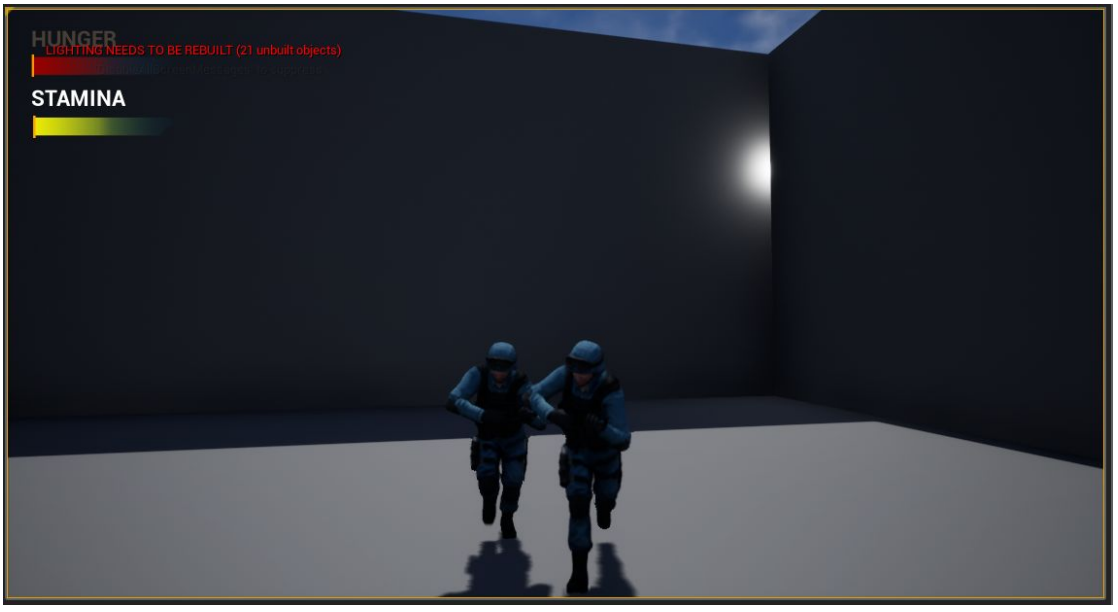

Figure 3 Chasing NPC

Figure 4 NPC Catching the player

Implementation of the behavior tree was easy but understanding it was hard. After understanding the basics of this tree, it is very easy to implement an AI for NPCs. I spent all of my time for the first week and half of the second week to understand this structure. I explained the things that I've learned for this part to my supervisor and teammate. However, while I was working on this tree, my teammate has already started to implement switching body function, and he couldn't understand the logic of the behavior tree. Therefore, to work together we needed to work on a single project, the supervisor told us to continue with my team mate's project, and he told me that he will include my code with a behavior tree when our internship ends.

After this part, we needed to work together and we searched for the ways to do it.

3.5 Learning Github for Unreal Engine 4

Before Github, I and the other intern tried that can we handle by just copy-paste issues. As a clear result no we couldn't do because besides code many factors help the game to be created, there are many visual objects, etc.

Therefore, we searched for collaboration in UE4. There are 3 ways to collaborate which are using Github, using Bitbucket and Source Tree, finally

using Perforce [3]. We read the comments and understand that Perforce is a faster way to do it. We tried perforce but although we watched different videos on Youtube, we couldn't succeed with Perforce. Then we tried Bitbucket and SourceTree, because this was the second-fastest solution, again we couldn't handle this one too, because there were many variables that we needed to consider.

Finally, we reached the solution of Github which was more familiar than the others. The first trials were always a failure. Then we tried many times and we understand the maşn point. We create 3 different workspaces for the same project the common named as master and we named our names to the others. Then we worked all day with our workspace at the end of the day we merge the project with the master in order. Then, the Github and collaboration issue was solved.

3.6 Focus on Game Feature Development

After the Github issue, we make different parts of the game. The supervisor had an idea for the hint option that the user will find something that shows the world with thermal vision effect. When the player looks at the door's security panel he will see the fingerprints' hotness. The strongest fingerprint seen with thermal vision is the last pushed button.

Although I found an easy way to implement a thermal vision effect to the game, the hardest part was come up with an idea that creates the fingerprints in the security panel and makes the thermal vision decrease for different fingerprints [4]. I thought that if I made different fingerprint shaped cylinders, and decrease their opacities based on the password, this can help. Also, I needed to implement disappearing fingerprint cylinders while playing the game. After creating the algorithm as I mention, the view looked as in the figures 5,6,7,8.

Figure 5 The Security Panel with normal vision.

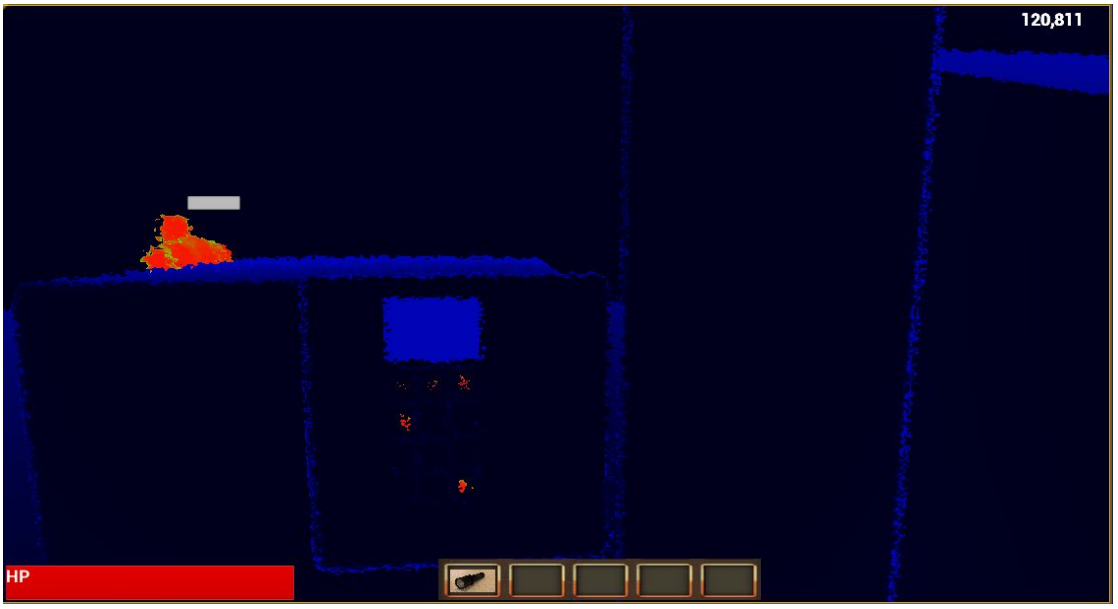

Figure 6 The Security Panel with thermal vision. The orange cylinders represents the fingerprints and the big orange one is the NPC character

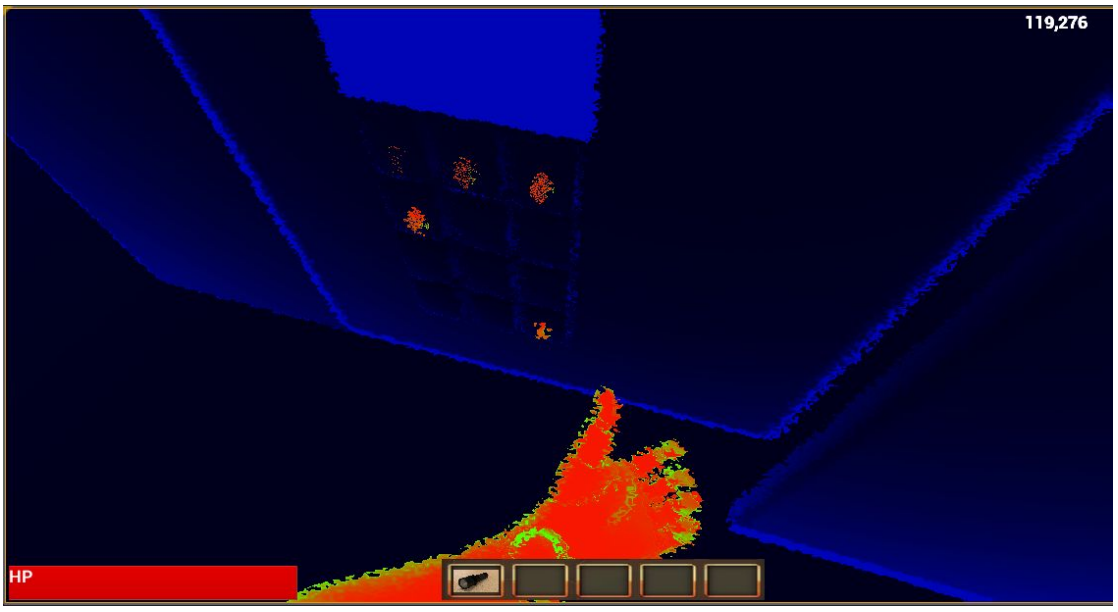

Figure 7 The thermal vision from closer look.

Figure 8 Thermal vision for normal usage. The orange ones are the NPCs. The bar on top of them shows their suspect to the player.

To finish this thermal part, I needed to implement a door opening and password entering part. Which I created a simple security panel and a door like in figure 5. Whenever the user collaborates with the security panel object a widget occurs and tells the user to press L to enter the password. The password screen occurs as in figure 9. I wrote all the codes of buttons one by one such as if the user pushes the 1 button to add 1 to the password and so on. If the password is matching with the correct one, the door is sliding to the

side or if its a laser door the lasers goes to the opposite sides such as in figure 10, 11.

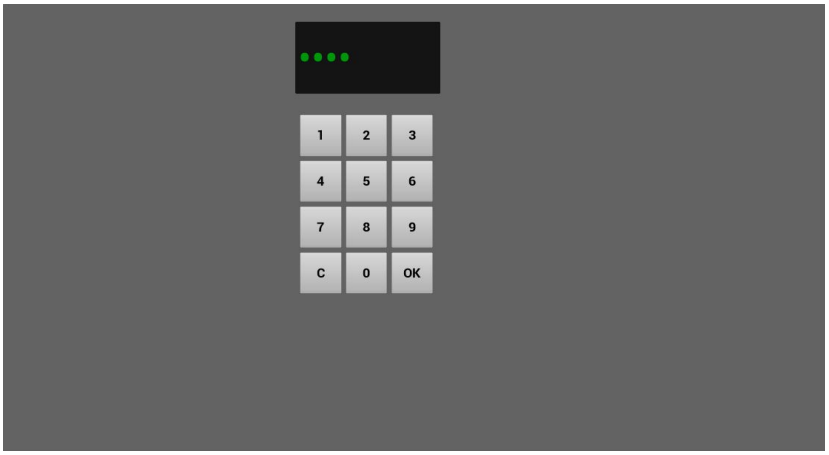

Figure 9 Password Screen Widget

Figure 10 Sliding door

Figure 11 Laser Door before openning

After finishing this part I began to the night vision part for a dark room. This was much easier than the thermal vision because I only play with some visual

values like seen color and so on. Therefore, this one includes playing with visual values, I didn't need a complex algorithm like above. Figure 12 represents the night vision.

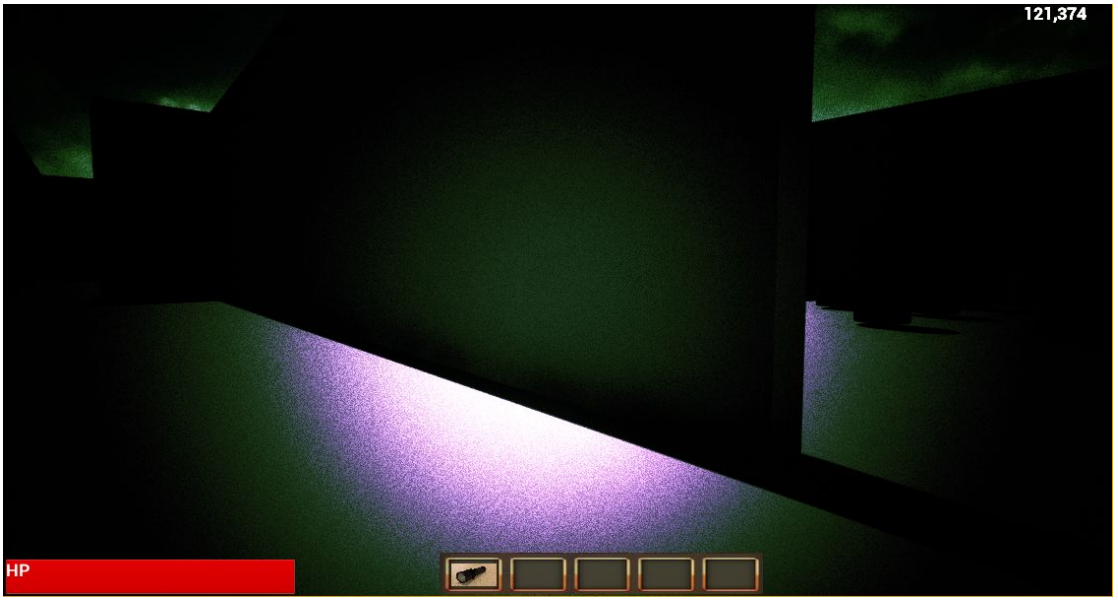

Figure 12 Night Vision

Because the area is a military area there should be some security cameras that see everywhere. To implement I search on the internet and found a solution to puta non-functional camera and get its view and project to the surface of something. I created a camera and a screen as in figure 13.

Figure 13 Security Camera view in the room.

The only problem was I don't want to record all the time this seen. I only wanted the camera record whenever the user enters the room. I created

collaborate in a room, whenever the player enters the room the camera starts recording like in figure 14, 15.

Figure 14 Before entering the room computer screen is empty.

Figure 14 After entering the room computer screen is recording the security camera.

Furthermore, I created a hack screen for the player to solve the hints and learn the information about himself and discard the security cameras. To implement it, first of all, I implemented the hacking screen. like in figure 9 but asking for username and password and have all the keyboard characters. As in that part, I implemented every button by myself, therefore, it took my time for a while. I turned screen like a hacking screen implement every part as a green color on a black screen. After the user hacks the computer the screen

seemed like in figure 15. After the hacking and learning the information computer screen became a noisy screen.

Figure 15 Hacked screen to learn the information. The writings came to the screen one letter by one to increase the literalism.

Also to hack the computer the necessary information put around the computer. Like the pinboard has a sentence which is for password and the letter for finding the username as in figure 16, 17.

Figure 16 Hint for password on pin board

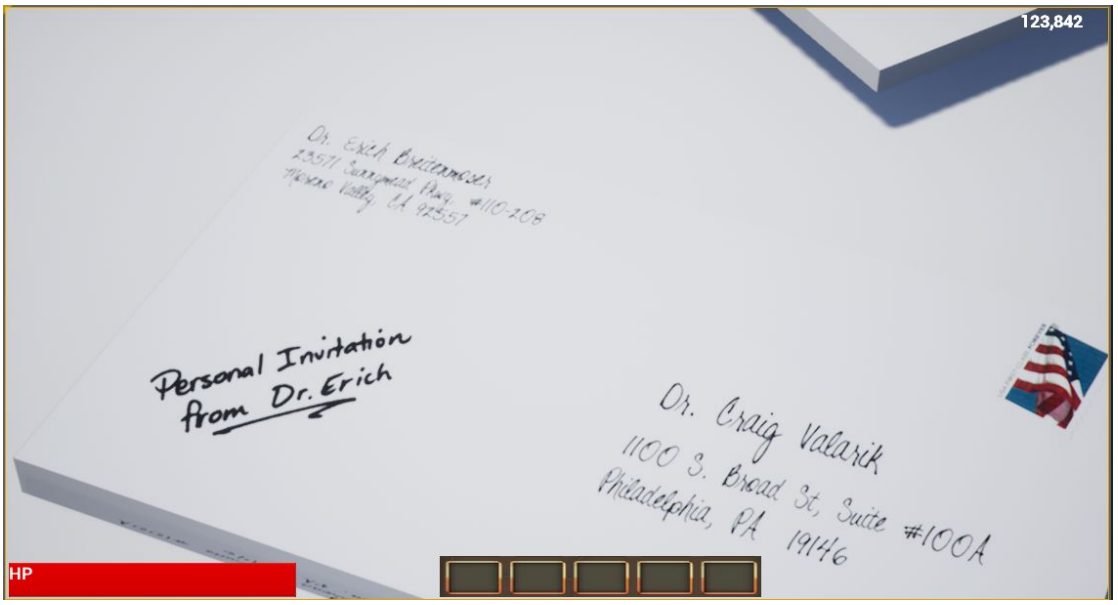

Figure 17 Hint for username on computer desktop

3.7 Complete the Basics of the Project

After finishing every part me and other intern merged them. In the end, we had almost all the features implemented. While implementing the features supervisor always checked what we have done so far and gave feedback to us. When we implemented the whole features together supervisor wanted a demo of the code to understand better and continue on that project. I told the things I have implemented and showed how I did to him.

4 Performance and Outcomes

4.1 Applying Knowledge and Skills Learned at Bilkent

During my internship, I needed to learn Unreal Engine in one month, add features to the game's topic, plan the game, implement the game. To do these, I used the project knowing that I've learned in every lecture at Bilkent University.

Almost every lecture at Bilkent University for Computer Science, we needed to implement some project. In the case of creating a project in Bilkent, I needed to think about the project, what to add as a feature and how. Then, I planed the project and implement it based on the lecturer's specified language for that project. If the language that specified is a new language for

me I needed to learn the language's basic implementations too. This project-based class helped me during my internship at Erik Games.

As I mentioned before, I was working with another intern. To work with him, I needed to have communication skills. I should have been working as a team. All the classes in Bilkent taught me working with a team and have good communication skills. Also to make the same project with different computers, we needed to learn Github for Unreal Engine 4 (UE4). CS319 has already taught us to use Github accounts for the project. However, we needed to combine this knowledge with UE4.

Also, to implement the game in Unreal Engine, I needed to implement good enough algorithms. The CS101-102-201-202-319 courses helped me during the algorithm phases. To pass this course I needed to learn the create algorithms and implementing them.

For testing the game I used every knowledge that I used in CS458. By applying this lecture's information I fixed many bugs.

To implement the hand tracking event to our game, I needed to learn somehow how to use it and give detailed information to my supervisor, I searched for hand tracking technics and needed features to implement this to him. Also, to play with the sight of the player character I needed to learn gaussian sight and other stuff. Therefore, I used the most important information that Bilkent taught us which is researching skills.

4.2 Solving Engineering Problems

Since we were creating a comprehensive PlayStation game, we need to think about the most efficient ways to implement the features. First of all, because none of the video games players like a game that freezes during the game, we needed to think about the algorithms that we've created. For example, in the part that the player character needed to hack the computer and discard the security cameras, the screen of the computer doesn't have the security camera feature until we enter the room. This and many other algorithms like this prevent the frozen game.

Also, when I and my team member finished the game, the owner of the company will continue to develop our game. Therefore while creating the game, I needed to be careful about the clearness of my codes. Most of my code was clean and understandable for people who will continue that project.

4.3 Team Work

From the beginning of the internship until the end, I worked with a person studying computer science at Bilkent University. The supervisor gave us the same project but different parts to move faster and asked us to work together to create the game. In the beginning, my part was creating AI characters of the game with a behavior tree and my partner's part was the same issue but without a behavior tree. The only time we study separately was this time because we needed to figure out which type was easier to implement, which is efficient in terms of time, etc.

After the first week, we shared the same project. To do this, we tried to understand GitHub in Unreal Engine 4(UE4). After we learned GitHub usage for UE4, we implemented different features during the day and spent the last hour to combine the parts into one single project. I believe that this was the most professional and efficient teamwork I have ever done as an engineer.

4.4 Multi-Disciplinary Work

Because the company I worked for is small, I worked with almost everyone in there. There were two company owners (the computer engineer one was my supervisor), two interns for the graphic design of the game, three interns including me. One of the company owners took care of the economics of the company, the other owner was my supervisor which was working on solving the bugs of their published game. The graphic interns worked with the third computer science intern and me and my teammate. Also, sometimes we asked some questions to the third computer science intern about UE4. Therefore, I can say that while I was working there, the work was multi-disciplinary.

4.5 Professional and Ethical Issues

While working in that company, I didn't come across with ant professional and ethical issues. Everyone in the company was friendly, they didn't cause any problem. Also, they were professional during my internship. They treat nice to me and also, each other.

4.6 Impact of Engineering Solutions

Even though we didn't use significant engineering solutions in our game, there was some chance to see some details improved the game's efficiency.

For example, as I mentioned in section 3.6, I tried to deactivate unnecessary events like security camera usage. Also, the best way to implement NPC characters was the behavior tree, however, because of the reasons that I mentioned in 3.4, we couldn't imply this to the game. However, because I keep in touch with the company still, I learned that they implement my behavior tree in the game recently.

Additionally, the planning in the first step helps us to finish all the features that we talked about till the end of the internship. That is impacted our project in a good way.

4.7 Locating Sources and Self-Learning

Self-learning is the significant skill that I learned in Bilkent, and also use it during my internship. Before coming to this internship I have no idea about how to use UE4 and no idea about how to make the game. Then I start researching on Youtube and Google.

Most of the time I used Youtube to learn to use the Unreal Engine, but sometimes when I need a document to understand the topic I used Google. I read some papers about the UE4 documents page to fully understand it. Some of them like that:

- Behavior Tree essentials [2]
- Rendering and Graphics [5]
- Skeletal Mesh and Animation System [6]

- Collaboration in UE4 [7]
- Thermal Vision[4]
- Night Vision [8]

If I encountered problems I generally look at the video's comments on Youtube or searched it on Stackoverflow. If still couldn't find it asked the supervisor or my team member

4.8 Knowledge about Contemporary Issues

The storytelling video games have some certain features to make it contemporary. One of them is using the Unreal Engine itself. It provides programmers the latest feature to create the game. Therefore, using the UE4 was the mıst significant way to make the game contemporary.

Also, to make it contemporary, the game should be easy to understand. If it is complicated it won't be easy to play and lose the contemporary property.

4.9 Using New Tools and Technologies

As I mention everywhere I used UE4 which is quite new technology to develop a game. From the beginning till the end of the internship, I learned UE4, developed a game's most of the features.

5 Conclusions

To Conclude, I've learned a new tool called Unreal Engine 4. In a month, I've learned how to make a third-person game and first-person game, how to plan and design the game, by using behavior tree how to make an AI brain for non-player characters (NPCs). Also, I've learned how to implement different visions for a player like night and thermal visions.

Also, working in a small company taught me communication, and by working with a team I've learned that collaboration by Github which brightens me for my future teams.

I believe that I’ve learned everything I’ve done during my internship. Therefore, I can honestly say that this was one of the most informative projects I’ve ever done.

All the code which include the behavior tree is below:
https://github.com/haiazey/FPSTrial
All the code which includes everything but not behavior tree is below:
https://github.com/SaidDemir/kilon

References

[1] “Game Development Kit”. https://en.wikipedia.org/wiki/Game_development_kit. [Accessed: Oct 18, 2019].

[2] “Behavior Trees”. https://docs.unrealengine.com/en-US/Engine/ArtificialIntelligence/BehaviorTrees/index.html . [Accessed: Aug 20, 2019].

[3] “Collaborate in UE4 ”. https://www.youtube.com/watch?v=-k1c1lo16q0. [Accessed: Aug 20, 2019].

[4] “Thermal Vision in UE4”. https://www.youtube.com/watch?v=9CpjV0a09pg&t=1030s. [Accessed: Aug 20, 2019].

[5] “Rendering and Graphics”. https://docs.unrealengine.com/en-US/Engine/Rendering/index.html. [Accessed: Aug 20, 2019].

[6] “Skeletal Mesh and Animation System”. https://docs.unrealengine.com/en-US/Engine/Animation/index.html [Accessed: Aug 20, 2019].

[7] “Collaboration in UE4”. https://docs.unrealengine.com/en-US/Engine/Basics/SourceControl/index.html [Accessed: Aug 20, 2019].

[8] “Night Vision ”. https://www.youtube.com/watch?v=O-0DDBn04mY&t=388s. [Accessed: Aug 20, 2019].

Self-Checklist for Your Report

Please check the items here before submitting your report. This signed checklist should be the final page of your report.

- □ Did you provide detailed information about the work you did?
- □ Is supervisor information included?
- □ Did you use the Report Template to prepare your report, so that it has a cover page, the 8 major sections and 13 subsections specified in the Table of Contents, and uses the required section names?
- □ Did you follow the style guidelines?
- □ Does you report look professionally written?
- □ Does your report include all necessary References, and proper citations to them in the body?
- □ Did you remove all explanations from the Report Template, which are marked with yellow color? Did you modify all text marked with green according to your case?

Signature: _____